Remarks

No amendments are made herein. Upon entry of this Response, claims 1-19 and 22-32 are pending. No new material is presented that would necessitate an additional search on the part of the Examiner.

Applicants note with appreciation that in the outstanding Office action the Examiner maintains that claims 26-28 contain allowable subject matter and merely objects to these claims as being dependent on a rejected base claim.

Applicants note with appreciation that the U.S. Patent and Trademark Office entered a Revocation of Previous Powers of Attorney and Appointment of New Power of Attorney in this application.

Prior to responding to the Office action, Applicants believe it would be of assistance to the Examiner to review the subject matter of independent claims 1 and 19.

Claim 1 is directed to a method for simulating dental procedures for training dental students including, in combination, the steps of: storing volumetric data defining the location of at least one isosurface in a model of a tooth; storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle; employing a digital computer consisting of a processor and a display device to display the model of a tooth; employing the processor and the display device to display the model of a dental tool having a handle; employing a haptic interface device including a force-feedback stylus that is manually moveable by a dental student and is coupled to the digital computer to move the model of a dental tool with respect to the model of a tooth; and employing the processor to compare the location of at least one isosurface in the model of a tooth with the positions of the feel points that define the surface of a model of a dental tool having a handle to calculate and apply computer-controlled interaction forces to the force-feedback stylus to simulate the feel of the dental tool having a handle to haptically simulate a dental procedure.

Claim 19 is directed to an apparatus for simulating dental procedures for training a dental student including, in combination, a digital computer consisting of at least a processor, a display device, a haptic interface including a moveable force-feedback stylus manipulatable by the student, and storage means for storing: volumetric object grid data for representing a tooth as the position and attributes of a collection of volume elements in three-dimensional space; tool

definition data for representing the position of feel points on the surface of a dental tool in three-dimensional space; and a simulation program executable by the processor in response to the movement of the stylus for moving a displayed model of the dental tool with respect to a displayed model of the tooth and for comparing the position of the feel points to the position of the volume elements for calculating and applying computer-controlled interaction forces to the force-feedback stylus to simulate the feel of the dental tool to haptically simulate a dental procedure.

Factual analysis of prior art shows that claims are not obvious

The Office action on p. 2 rejects claims 1, 9-12, 15-19, 22-25, and 29-32 under 35 U.S.C. §103(a) in view of Arnold et al. (Virtual teeth for endodontics training and practice, published and presented at International Conference on Information Visualization, IV, July 19-21, 2000) in combination with Tarr (U.S. patent number 6,191,796 issued February 20, 2001) and NASA Tech Briefs (Haptic Technologies' PenCAT/Pro 3D pen, October, 1998).

The ultimate determination of whether an invention would have been obvious under 35 U.S.C. §103(a) is a legal conclusion based on underlying findings of fact. *In re Kotzab,* 217 F.3d 1365, 1369 (Fed. Cir. 2000).

As a preliminary matter, the Supreme Court in *Graham v. John Deere*, 383 U.S. 1 provided an analytical construct to be used when determining whether claims are obvious under 35 U.S.C. §103(a) in view of prior art. One aspect of this analytical construct includes characterizing the prior art, as a background for a legal analysis.

Arnold et al. (published and presented at International Conference on Information Visualization, IV, July 19-21, 2000)

Arnold shows use of virtual environments in endodontics and use of haptic feedback. (Arnold et al., Abstract, and p. 600 right column). Arnold shows a haptic tooth viewer designed for use with a PenCat force feedback device (Ibid. p. 600 right column). Arnold states, "[t]he PenCat itself is a device with just two degrees of freedom, limiting the input interaction to only two dimensions." Ibid. p. 601 left column, [emphases added]. The third dimension is required to be simulated and Arnold shows a Force Mesh, which is a 2D array containing a height map of the object being modeled (Ibid. p. 601 right column). Arnold states, "[u]sing this kind of force

representation restricts a 'touch-view' to a single aspect and the full 3D representation can only be generated with multiple views." Ibid. p. 601 right column, [emphases added]. Thus, Arnold's device merely allows for force feedback from a single viewpoint and only in real time (Ibid. p. 601 right column).

The user of the device in Arnold merely moves a cursor over the Force Mesh (Ibid. p. 601 right column). "This provides an almost solely touch oriented interaction as the only visible data is a wireframe representation of the Force Mesh." Ibid. p. 601 right column, [emphases added]. The user of the device in Arnold merely feels the bumps and ridges of a tooth with the PenCat (Ibid. p. 602 left column).

Further, Arnold states that the PenCat device imposes severe limitations, allowing only two degrees of freedom (Ibid. p. 602 left column). From what is shown in this article, Arnold concludes, "[i]t is important to note however that using devices that are more complex would require a completely different interaction approach, as currently there is no standard interface for them." Ibid. p. 602 left column, [emphases added].

The Office action admits that Arnold fails to teach or suggest storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle, which is the subject matter of claim 1. See Office action on pp. 3 and 8.

Nowhere does Arnold show employing a haptic interface device including a force-feedback stylus that is manually moveable by a dental student and is coupled to the digital computer to move the model of a dental tool with respect to the model of a tooth. Arnold merely shows moving a cursor over a Force Mesh to feel bumps and ridges of a tooth.

Arnold fails to teach or suggest employing the processor to compare the location of at least one isosurface in the model of a tooth with the positions of the feel points that define the surface of a model of a dental tool having a handle to calculate and apply computer-controlled interaction forces to the force-feedback stylus to simulate the feel of said dental tool having a handle to haptically simulate a dental procedure.

As admitted in the Office action, nowhere does Arnold show multiple feel points on a dental tool. Further, nowhere does Arnold show simulating a dental procedure. Arnold merely shows moving a cursor over a Force Mesh to feel bumps and ridges of a tooth.

The Office action on p. 7 alleges that Arnold shows a model of a dental tool having a handle because Arnold on p. 603 states, "[t]he new generation of 3D haptic feedback devices will be used so that the user can 'feel' as he sees the instrument being directed through the root canal."

However Arnold fails to teach, or suggest examples of an instrument, let alone teach or suggest that the instrument is a dental tool. Arnold merely shows moving a cursor over a Force Mesh to feel bumps and ridges of a tooth. Nowhere does Arnold teach or suggest that the cursor is visible during movement.

Further, nowhere does Arnold teach or suggest that such new generation devices would be compatible and operable with the device shown in Arnold. In fact, Arnold teaches away from combining the present device with new generation devices as Arnold states, "[i]t is important to note however that using devices that are more complex would require a completely different interaction approach, as currently there is no standard interface for them." Ibid. p. 602 left column, [emphases added].

Thus, Arnold fails to teach or suggest employing a processor and a display device to display the model of a dental tool having a handle, which is the subject matter of claim 1.

Nowhere does Arnold teach or suggest storing tool definition data for representing the position of feel points on the surface of a dental tool in three-dimensional space, which is the subject matter of claim 19.

Arnold fails to teach or suggest a simulation program executable by the processor in response to the movement of the stylus for moving a displayed model of the dental tool with respect to a displayed model of the tooth, which is the subject matter of claim 19. Arnold fails to teach or suggest comparing the position of the feel points to the position of the volume elements for calculating and applying computer-controlled interaction forces to the force-feedback stylus to simulate the feel of the dental tool to haptically simulate a dental procedure, which is the subject matter of claim 19.

In contrast to the subject matter of claim 19, Arnold merely shows a device that allows a user to move a cursor over a Force Mesh to feel bumps and ridges of a tooth.

For any of these reasons, Arnold alone fails to render obvious the subject matter of claims 1 and 19. Claims 9-12, 15-18, 22-25, and 29-32 depend directly or indirectly from claim 1 or

claim 19 and include all of the subject matter of these claims and further include additional subject matter. Therefore Arnold also fails to render obvious claims 9-12, 15-18, 22-25, and 29-32.

Applicants show below that Tarr fails to cure the defects of Arnold.

Tarr (U.S. patent number 6,191,796, issued February 20, 2001, filed January 21, 1998)

Tarr shows a method for haptically deforming a virtual surface within a haptic virtual environment (Tarr, Abstract). The virtual deformable surface is represented by a mesh of polygons such as triangles (Ibid. column 2 lines 6-7). A position of a user in real space is sensed, and a haptic interface location is determined in the haptic interaction space in response to the position of the user in real space (Ibid. column 2 lines 7-12). A determination is made whether the virtual surface collides with the haptic interface location (Ibid. column 2 lines 12-13). If the virtual surface does not collide with the haptic interface location, a first force is calculated and applied to the user in real space in response to this haptic interface location (Ibid. column 2 lines 14-17).

Alternatively in Tarr, if the virtual surface is determined to collide with the haptic interface location, an interaction force between the virtual surface and the user is calculated (Ibid. column 2 lines 17-21). If the calculated interaction force exceeds a predetermined threshold force, the virtual surface is deformed and a force is calculated and applied to the user in real space in response to the interaction force (Ibid. column 2 lines 21-24).

Most important, Tarr shows that the virtual tool in his device is a volume shape such as a sphere, a cuboid, or a toroid (Ibid. column 16 lines 29-30, Fig. 1D #56, and Fig. 28B #606).

Tarr fails to teach or suggest a method or apparatus for simulating dental procedures for training dental students, which is the subject matter of claims 1 and 19. Nowhere does Tarr teach or suggest storing volumetric data defining the location of at least one isosurface in a model of a tooth, which is the subject matter of claim 1. Nowhere does Tarr teach or suggest employing a digital computer consisting of a processor and a display device to display the model of a tooth, which is the subject matter of claim 1. Tarr fails to teach or suggest storing volumetric object grid data for representing a tooth as the position and attributes of a collection of volume elements in three-dimensional space, which is the subject matter of claim 19. Rather

Tarr merely shows virtual geometric objects such as squares, cubes, triangles, and trapezoids. In fact, Tarr fails even to mention the word tooth.

Nowhere does Tarr teach or suggest employing the processor and the display device to display the model of a dental tool having a handle, which is the subject matter of claim 1. Nowhere does Tarr teach or suggest a simulation program executable by the processor in response to the movement of the stylus for moving a displayed model of the dental tool with respect to a displayed model of the tooth, which is the subject matter of claim 19. Tarr merely shows examples of virtual tools that are squares, cubes, triangles, and trapezoids (Ibid. column 16 lines 29-30, Fig. 1D #56, and Fig. 28B #606).

The Office action on p. 3 alleges that Tarr teaches or suggests storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle. The Office action bases this allegation on Tarr teaching a series of discrete points in virtual space which form the volumetric shape (Tarr column 5 lines 42-44). Applicants respectfully disagree.

In fact, Tarr on column 5 lines 44-46 states, "FIG. 1D shows an example of a virtual surface 32 and a 'tool' **56**." Further, Fig. 1D in Tarr shows that tool **56** is a sphere. The examples of virtual tools shown in Tarr are simple geometric shapes, for example, a sphere, a cuboid, or a toroid (Ibid. column 16 lines 29-30, Fig. 1D #56, and Fig. 28B #606).

Tarr fails to teach or suggest storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle, which is the subject matter of claim 1. Tarr further fails to teach or suggest storing tool definition data for representing the position of feel points on the surface of a dental tool in three-dimensional space, which is the subject matter of claim 19. In fact Tarr never even mentions the words dental tool, or handle.

For any of these reasons, Tarr fails to cure the defects of Arnold, and therefore fails to render obvious the subject matter of claims 1 and 19, alone or in combination with Arnold. Claims 9-12, 15-18, 22-25, and 29-32 depend directly or indirectly from claim 1 or claim 19 and include all of the subject matter of these claims and further include additional subject matter. Therefore Tarr in combination with Arnold also fails to render obvious claims 9-12, 15-18, 22-25, and 29-32.

Applicants show below that NASA Tech Briefs fail to cure the defects of Tarr and Arnold, alone or in combination.

NASA Tech Briefs (Haptic Technologies' PenCAT/Pro 3D pen, October, 1998), herein after called "NASA"

NASA shows a Haptic Technologies' PenCAT/Pro 3D pen (herein after called "the pen"). NASA shows that the pen allows CAD designs and 3D modelers to feel objects on the computer screen.

NASA fails to teach or suggest a method or apparatus for simulating dental procedures for training dental students, as is the subject matter of claims 1 and 19. Nowhere does NASA teach or suggest storing volumetric data defining the location of at least one isosurface in a model of a tooth, which is the subject matter of claim 1. Nowhere does NASA teach or suggest employing a digital computer consisting of a processor and a display device to display the model of a tooth, which is the subject matter of claim 1.

Nowhere does NASA teach or suggest employing the processor and the display device to display the model of a dental tool having a handle. Nowhere does NASA teach or suggest employing the processor to compare the location of at least one isosurface in the model of a tooth with the positions of the feel points that define the surface of a model of a dental tool having a handle to calculate and apply computer-controlled interaction forces to the force-feedback stylus to simulate the feel of the dental tool having a handle to haptically simulate a dental procedure, which is the subject matter of claim 1.

NASA fails to teach or suggest storing volumetric object grid data for representing a tooth as the position and attributes of a collection of volume elements in three-dimensional space, which is the subject matter of claim 19.

Nowhere does NASA teach or suggest storing tool definition data for representing the position of feel points on the surface of a dental tool in three-dimensional space, which is the subject matter of claim 19.

For any of these reasons, NASA fails to cure the defects of Arnold and Tarr, alone or in any combination, and thus fails to render obvious the subject matter of claims 1 and 19. Claims 9-12, 15-18, 22-25, and 29-32 depend directly or indirectly from claim 1 or claim 19 and include all of the subject matter of these claims and further include additional subject matter.

Therefore NASA in combination with Arnold and Tarr also fails to render obvious claims 9-12, 15-18, 22-25, and 29-32.

Legal analysis of references combined

According to a summary of criteria in the *Manual of Patent Examining Procedure,* "[t]o establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." [emphases added] *Manual of Patent Examining Procedure* §2142 (8th Ed. Rev.2, May 2, 2004, "hereinafter M.P.E.P."); *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

A recent decision by the U.S. Supreme Court, *KSR International Co. v. Teleflex Inc.* 550 U.S.____ (2007), discusses criteria for showing a motivation to combine numerous prior art references in a determination that a claimed invention is obvious. The U.S. Supreme Court in *KSR* explained that "[t]here is no necessary inconsistency between the idea underlying the TSM [teaching, success, motivation] test and the *Graham* analysis." *KSR International Co.* 550 U.S.____ at p. 15. In fact, the court explains "... it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the newly claimed invention does." Id.

Applicants respectfully traverse the above rejection, and show that the facts of the case and the relevant case law indicate that the invention would not have been obvious to one of ordinary skill in the art at the time the application was filed because the underlying facts show that the criteria for a *prima facie* rejection have not been met.

Failure of the cited prior art to teach or suggest all the claim limitations

To establish a *prima facie* case for obviousness of a claimed invention, all of the claim limitations must be taught or suggested by the prior art. M.P.E.P. §2143.03; *In re Royka,* 490 F.2d 981, 180 USPQ 580 (CCPA 1974).

An element of claim 1 is storing point data defining the positions of a plurality of feel

points that define the surface of a model of a dental tool having a handle. An element of claim 19 is storing tool definition data for representing the position of feel points on the surface of a dental tool in three-dimensional space. As shown below, none of the cited references teach or suggest these elements of claim 1 and claim 19.

Arnold's device merely allows for force feedback from a single viewpoint and only in real time (Ibid. p. 601 right column). The device in Arnold merely allows the user to move a cursor over a Force Mesh (Ibid. p. 601 right column). In fact, the Office action admits on pp. 3 and 8 that Arnold does not teach or suggest storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle, which is the subject matter of claims 1 and 19.

Tarr merely shows that the virtual tool in his method is a volume shape such as a sphere, a cuboid, or a toroid (Ibid. column 16 lines 29-30, Fig. 1D #56, and Fig. 28B #606). Nowhere does Tarr teach or suggest storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle, which is the subject matter of claims 1 and 19. NASA fails to teach or suggest any processor for storing any data, let alone storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle, which is the subject matter of claims 1 and 19. Therefore, neither Tarr nor NASA cures the defects of Arnold with respect to at least these claim elements of claim 1 and 19.

Therefore, by the legal criteria discussed above, the underlying facts of the content of the cited prior art and of the present pending claims show that the prior art fails to teach or suggest all the limitations of the claims of the present invention. Therefore, a *prima facie* case that claims 1and 19 of the present invention are obvious has not been made.

Claims 9-12, 15-18, 22-25, and 29-32 that depend directly or indirectly from claims 1 or 19 and incorporate all of the subject matter of claims 1 or 19 and contain additional subject matter also are not obvious in light of the cited references.

For at least this reason, obviousness of the claims has not been established.

Lack of motivation to combine the cited prior art

To establish a *prima facie* case of obviousness, a reasonable expectation of success must be found in the prior art, and not based on Applicants' disclosure. The mere fact that references

can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills,* 916 F.2d 680, 16 USPDQ 1430 (Fed. Cir. 1990). The U.S. Supreme Court in *KSR International Co. v. Teleflex Inc.* 550 U.S.____ (2007), a decision that issued on April 30, 2007, affirmed the legal principle that the mere fact that each element of a claimed invention could be found within the prior art does not render the claimed invention obvious. The court stated:

> .... A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR International Co.* 550 U.S.____ at p. 14

"A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention." M.P.E.P. §2141.02 citing *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540 (Fed. Cir. 1983), [emphasis in original]. This legal principle was affirmed by the U.S. Supreme Court in *KSR* when the court stated, "...when the prior art teaches away from combining certain known elements, discovery of a successful means of combining them is more likely to be nonobvious." *KSR International Co.* 550 U.S.____ at p. 12, [emphases added]. Applicants show below that Arnold teaches away from combining his device with other devices.

Arnold merely teaches a device that allows for force feedback from a single viewpoint and only in real time (Ibid. p. 601 right column). The device in Arnold merely allows the user to move a cursor over a Force Mesh (Ibid. p. 601 right column). "This provides an almost solely touch oriented interaction as the only visible data is a wireframe representation of the Force Mesh." Ibid. p. 601 right column, [emphases added]. The device in Arnold is limited to allowing a user to merely feel the bumps and ridges of a tooth with the PenCat (Ibid. p. 602 left column). Arnold in fact teaches that the PenCat device imposes severe limitations, allowing only two degrees of freedom (Ibid. p. 602 left column).

One of ordinary skill in the art of haptic technology, reading Arnold, would not have been motivated to combine Arnold's device with any other device to arrive at the subject matter of the present claims because Arnold concludes from his experiment, "[i]t is important to note however that using devices that are more complex would require a completely different interaction approach, as currently there is no standard interface for them." Ibid. p. 602 left

column, [emphases added]. From this statement, the ordinarily skilled user would have been motivated against combining Arnold with other art.

One of ordinary skill in the art simply would not have been taught or given the suggestion to combine Arnold with Tarr and NASA because Arnold, as a whole, states that his device is limited to what is shown in his paper and that to combine the device in Arnold with the device in Tarr would require a completely different interaction approach. In fact, one of ordinary skill in the art would have been taught or given the suggestion that combining Tarr with Arnold would render the device in Arnold inoperative.

Even further, there was no suggestion to one of ordinary skill in the art of haptic technology that the combination of Arnold, Tarr, and NASA would have been successful. In fact, the prior art teaches and suggests that making such a combination would have been unsuccessful, as shown below.

Factual analysis above shows that Arnold's device is limited to what is shown in his paper and that combining Arnold with other devices would require a completely different interaction approach. Thus, the facts show that there is no suggestion of a reasonable expectation of success had the combination been made. Rather, the prior art teaches and suggests that such a combination would have been unsuccessful. Thus, making the combination is using Applicants' own specification as a blueprint to attempt to reconstruct the invention, which is impermissible hindsight.

Therefore, by the legal criteria discussed above, the underlying facts of the content of the cited prior art show that Arnold teaches away from the combination of the device in Arnold with other devices. Therefore the prior art fails to suggest to the ordinarily skilled artisan the desirability of the combination and further fails to suggest to the ordinarily skilled artisan a reasonable expectation of success in making the combination of Arnold, Tarr, and NASA. Therefore, a *prima facie* case that claims 1 and 19 of the present invention are obvious has not been made.

Claims 9-12, 15-18, 22-25, and 29-32 that depend directly or indirectly from claims 1 or 19 and incorporate all of the subject matter of claim 1 or claim 19 and contain additional subject matter also are not obvious in light of the cited references.

For at least this reason, obviousness of the claims has not been established.

Proposed modification changes the principle of operation

According to criteria established in the M.P.E.P., "[i]f the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious." M.P.E.P. §2143.01.

In *In re Ratti*, 270 F.2d 810 (CCPA 1959), claims were directed to an oil seal having a bore engaging portion with outwardly biased resilient spring fingers inserted in a resilient sealing member. See M.P.E.P. §2143.01. The primary reference relied upon in a rejection based on a combination of references showed an oil seal in which the bore engaging portion was reinforced by a cylindrical sheet metal casing. See M.P.E.P. §2143.01. The prior art device required rigidity for operation, whereas the claimed invention required resiliency. See M.P.E.P. §2143.01. The court reversed the rejection holding that the "suggested combination of references would require a substantial reconstruction and redesign of the elements shown in [the primary reference] as well as a change in the basic principle under which the [primary reference] construction was designed to operate." See M.P.E.P. §2143.01 citing *In re Ratti* 270 F.2d at 813.

Similar to the decision in *In re Ratti*, Applicants show below that combining the device in Arnold with the device in Tarr requires reconstruction and change in the basic principles of operation of the device in Arnold and thus there would have been no motivation to combine Arnold with Tarr.

Arnold shows a haptic tooth viewer designed for use with the PenCat force feedback device (Ibid. p. 600 right column). Arnold shows that the PenCat device imposes severe limitations (Ibid. p. 602 left column), and states, "[t]he PenCat itself is a device with just two degrees of freedom, limiting the input interaction to only two dimensions." Ibid. p. 601 left column, [emphases added].

To compensate for the limitations of the PenCat, Arnold shows construction of a program to simulate the third dimension, a Force Mesh, which is a 2D array containing a height map of the object being modeled (Ibid. p. 601 right column). Arnold further shows replacing the visual representation of the Force Mesh with the original model to retain the generated forces (Ibid. p. 602 left column).

The user of the device in Arnold moves a cursor over the Force Mesh (Ibid. p. 601 right column), so that the user merely feels the bumps and ridges of a tooth with the PenCat (Ibid. p. 602 left column).

To combine the more complex device in Tarr with the device in Arnold to arrive at the subject matter of claim 1 and claim 19 would require a complete reconstruction and change in the basic principles of operation of the device in Arnold, because Arnold states, "[i]t is important to note however that using devices that are more complex would require a completely different interaction approach, as currently there is no standard interface for them." Ibid. p. 602 left column, [emphases added].

Therefore, there was no motivation to combine the device in Arnold with the device in Tarr as such a combination would have required a complete reconstruction and change in the basic principles of operation of the device in Arnold. See M.P.E.P. §2143.01 citing *In re Ratti*, 270 F.2d 810. Therefore, a *prima facie* case that claim 1 and claim 19 of the present invention are obvious has not been made.

Claims 9-12, 15-18, 22-25, and 29-32 that depend directly or indirectly from claim 1 or claim 19 and incorporate all of the subject matter of claim 1 or claim 19 and contain additional subject matter also are not obvious in light of the cited references.

For any of the above reasons, obviousness of the claims has not been established. Applicants respectfully request withdrawal of rejection of claims 1, 9-12, 15-19, 22-25, and 29-32 under 35 U.S.C. §103(a).

Arnold et al. (Virtual teeth for endodontics training and practice, published and presented at International Conference on Information Visualization, IV, July 19-21, 2000) in combination with Tarr (U.S. patent number 6,191,796 issued February 20, 2001), NASA Tech Briefs (Haptic Technologies' PenCAT/Pro 3D pen, October, 1998), and Hayka et al. (U.S. patent number 5,688,118, issued November 18, 1997)

The Office action on p. 6 rejects claims 2-8, 13-14, and 16 under 35 U.S.C. §103(a) in view of Arnold et al. (Virtual teeth for endodontics training and practice, published and presented at International Conference on Information Visualization, IV, July 19-21, 2000) in combination with Tarr (U.S. patent number 6,191,796 issued February 20, 2001), NASA Tech

Briefs (Haptic Technologies' PenCAT/Pro 3D pen, October, 1998), and Hayka et al. (U.S. patent number 5,688,118, issued November 18, 1997). Applicants respectfully traverse.

Arnold et al., Tarr, and NASA et al. are characterized above. Hayka et al. fails to cure any of the defects of Arnold et al., Tarr, and NASA et al. alone or in any combination, as is shown below.

Hayka et al. (U.S. patent number 5,688,118, issued November 18, 1997)

Hayka shows a device for simulating drilling a real tooth by drilling an artificial tooth, in which the procedure is displayed in an enlarged scale on a display (Hayka column 8 lines 36-42). The device includes a dental hand-piece with a drilling end and an attached compressed gas line (Ibid. column 9 lines 1-10 and column 10 lines 9-18). Compressed gas is used to rotate the drilling end for penetrating the artificial tooth (Ibid. column 10 lines 19-20).

The device further includes an artificial tooth located on a platform, a sensor attached to the dental hand-piece, an adaptor which transmits the image of the drilling actually being performed on the artificial tooth to a display, and a display unit which displays an enlarged scale of the artificial tooth being drilled (Ibid. columns 9-10, and Fig. 4). The artificial tooth is made of a substance with a hardness that is similar to the hardness of enamel or dentin (Ibid. column 10 lines 10-46 and Fig. 4 #74).

Nowhere does Hayka teach or suggest any method for simulating a dental procedure using haptic technology. Nowhere does Hayka teach or suggest storing volumetric data defining the location of at least one isosurface in a model of a tooth. In fact, Hayka never even mentions the words "isosurface" or "model" because Hayka's device is based on using an artificial tooth and not haptic technology. Hayka is actually drilling an actual artificial tooth made of a substance.

Hayka fails to teach or suggest storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle, which is the subject matter of claim 1. In contrast to the subject matter of claims 1, Hayka shows using an actual dental drill with compressed gas and an actual rotating drill end.

Nowhere does Hayka teach or suggest employing a haptic interface device including a force-feedback stylus that is manually moveable by a dental student and is coupled to the digital computer to move the model of a dental tool with respect to the model of a tooth.

Nowhere does Hayka teach or suggest employing the processor to compare the location of at least one isosurface in the model of a tooth with the positions of the feel points that define the surface of a model of a dental tool having a handle to calculate and apply computer-controlled interaction forces to the force-feedback stylus to simulate the feel of the dental tool having a handle to haptically simulate a dental procedure.

For at least these reasons, Hayka fails to cure the defects of Arnold, Tarr, and NASA alone or in combination, and thus fails to render obvious the subject matter of claims 1. Claims 2-8, 13-14, and 16 depend directly or indirectly from claim 1 and include the subject matter of this claim and further include additional subject matter. Therefore Hayka in combination with Arnold, Tarr, and NASA also fails to render obvious claims 2-8, 13-14, and 16.

As discussed above, a *prima facie* case of obviousness requires some suggestion or motivation to modify the reference or to combine reference teachings, a reasonable expectation of success, and that the prior art reference (or references when combined) must teach or suggest all the claim limitations.

Factual analysis above shows that none of Arnold, Tarr, and NASA teach or suggest storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle, which is the subject matter of claim 1.

Hayka does not cure any of these defects. Hayka teaches using an actual dental drill with compressed gas and an actual rotating drill end, and displaying an enlarged scale of the artificial tooth being drilled on a display. Nowhere does Hakya teach or suggest storing point data defining the positions of a plurality of feel points that define the surface of a model of a dental tool having a handle. Hayka is actually drilling an actual artificial tooth made of a substance.

Therefore none of the cited prior art references teach or suggest this element of claim 1 and a *prima facie* case of obviousness has not be established. Claims 2-8, 13-14, and 16 depend directly or indirectly from claim 1 and include the subject matter of this claim and further include additional subject matter. Therefore Hayka in combination with Arnold, Tarr, and NASA also fails to render obvious claims 2-8, 13-14, and 16.

Further, Applicants show below that none of the prior art references, taken as a whole at the time the application was filed, would have motivated or suggested to one of ordinary skill, at

the time the present application was filed, combining these references, let alone having motivated the invention of the claims, let alone providing an expectation of success.

The device in Hayka relies on an artificial tooth, dental drill, and compressed gas to produce a simulation using a dental drill to drill an artificial tooth. In contrast to the device in Hayka, Arnold, Tarr, and NASA are virtual reality devices that use haptic technology. One of ordinary skill in the art of haptic technology would not have been taught or suggested to combine this technology with the technology in Hayka.

Further, one of ordinary skill in the art of haptic technology, reading Arnold, would not have been motivated to combine Arnold's device with any other device to arrive at the subject matter of the present claims because Arnold concludes from his experiment, "[i]t is important to note however that using devices that are more complex would require a completely different interaction approach, as currently there is no standard interface for them." Ibid. p. 602 left column, [emphases added].

One of ordinary skill in the art simply would not have been taught or given the suggestion to combine Arnold with Hayka and further with Tarr and NASA because Arnold, as a whole, states that his device is limited to what is shown in his paper and that to combine the device in Arnold with the device in Hayka and Tarr would require a completely different interaction approach. In fact, one of ordinary skill in the art would have been taught or given the suggestion that combining Tarr and Hayka with Arnold would render the device in Arnold inoperative.

Even further, legal criteria propounded in the M.P.E.P. establish that if the proposed modification would render the prior art technology unsatisfactory for its intended purpose, then there can be no suggestion or motivation to make the proposed modification. M.P.E.P. §2143.01; *In re Gordon,* 733 F.2d 900, 221 U.S.P.Q. 1125 (Fed. Cir. 1984).

To modify the device in Hayka et al. for combination with the devices in Arnold, Tarr, and NASA to have attempted to reconstruct the claims of the present invention, would have required omitting Hayka's artificial tooth, dental drill, and compressed gas. The device in Hayka relies on these elements to function for its intended purpose as this device produces a simulation by using an actual dental drill to actually drill an artificial tooth. The technology in Hayka et al. cannot function for its intended purpose if these elements are removed.

For at least these reasons, one of ordinary skill in the art, would have no motivation to combine Hayka with Arnold, Tarr, and NASA.

Even further, there was no suggestion to one of ordinary skill in the art of haptic technology that the combination of Hayka, Arnold, Tarr, and NASA would have been successful. The facts show that there is no suggestion from the prior art to combine the cited references to try the claimed method, and no suggestion of a reasonable expectation of success had the combination been made. In fact, Arnold teaches away from combining his device with other devices.

Thus, the facts show that there is no suggestion of a reasonable expectation of success had the combination been made. Rather, the prior art teaches and suggests that such a combination would have been unsuccessful. Thus, making the combination is using Applicants' own specification as a blueprint to reconstruct the invention, which is impermissible hindsight.

Therefore the prior art fails to suggest to the ordinarily skilled artisan the desirability of the combination and further fails to suggest to the ordinarily skilled artisan a reasonable expectation of success in making the combination of Hayka, Arnold, Tarr, and NASA. Therefore, a *prima facie* case that claim 1 of the present invention is obvious has not been made.

Claims 2-8, 13-14, and 16 that depend directly or indirectly from claim 1 and incorporate the subject matter of claim 1 and contain additional subject matter also are not obvious in light of the cited references.

For any of the above reasons, obviousness of the claims has not been established. Applicants respectfully request withdrawal of rejection of claims 2-8, 13-14, and 16 under 35 U.S.C. §103(a).

Arnold et al. is not proper prior art

The Office action on p. 2 rejects claims 1, 9-12, 15-19, 22-25, and 29-32 under 35 U.S.C. §103(a) in view of Arnold et al. (Virtual teeth for endodontics training and practice, published and presented at International Conference on Information Visualization, IV, July 19-21, 2000) in combination with Tarr (U.S. patent number 6,191,796 issued February 20, 2001) and NASA Tech Briefs (Haptic Technologies' PenCAT/Pro 3D pen, October, 1998).

The Office action on p. 6 rejects claims 2-8, 13-14, and 16 under 35 U.S.C. §103(a) in view of Arnold et al. (Virtual teeth for endodontics training and practice, published and presented at International Conference on Information Visualization, IV, July 19-21, 2000) in combination with Tarr (U.S. patent number 6,191,796 issued February 20, 2001), NASA Tech Briefs (Haptic Technologies' PenCAT/Pro 3D pen, October, 1998), and Hayka et al. (U.S. patent number 5,688,118, issued November 18, 1997).

Arnold et al. (published and presented at International Conference on Information Visualization, IV, July 19-21, 2000)

A reference used in a 35 U.S.C. §103(a) rejection must qualify as prior art under 35 U.S.C. §102. See 35 U.S.C. §103(a). According to criteria established in the M.P.E.P., "when the reference is not a statutory bar under 35 U.S.C. §102(b), (c), or (d), applicant can overcome the rejection by swearing back the reference through the submission of an affidavit under 37 C.F.R. 1.131." M.P.E.P. §2132.01. "Affidavits or declarations under 37 C.F.R. 1.131 may be used to antedate a reference or activity that qualifies as prior art under 35 U.S.C. 102(a) and not under 35 U.S.C. 102(b), e.g., where the prior art date under 35 U.S.C. 102(a) of the patent, the publication or activity used to reject the claim(s) is less than 1 year prior to applicant's or patent owner's effective filing date." M.P.E.P. §715.

Applicants respectfully traverse the above rejection for the reasons shown below, viz., that Arnold (July, 2000) is not prior art.

Arnold was published and presented at International Conference on Information Visualization, IV on July 19-21, 2000.

Applicants herewith submit a 37 C.F.R. §1.131 Declaration of three co-inventors, John Ranta, R. Bruce Donoff, and Linda P. Nelson, as evidence that the invention was made prior to publication of Arnold on July 19, 2000. See Appendix **A** attached hereto which is the Declaration of the inventors, hereinafter the "Declaration of the inventors".

Attempts to contact fourth co-inventor Dr. Walter Aviles have been unsuccessful. A letter with the Declaration of the inventors enclosed was sent certified mail return receipt requested to Dr. Aviles last known home address, which letter was delivered on May 16, 2007. See Appendix **B** attached hereto which is a copy of the certified mail receipt and a printout of delivery confirmation from the U.S. Postal Service web site. Another letter with the Declaration

of the inventors enclosed was sent certified mail return receipt requested to the address of Dr. Aviles' employer, which letter was delivered on May 16, 2007. See Appendix **C** attached hereto which is a copy of the certified mail receipt and a printout of delivery confirmation from the U.S. Postal Service web site. Dr. Aviles has not responded to either of these letters.

An electronic message (email) was sent to the co-inventors of this application, including Dr. Aviles, on April 12, 2007 with the Declaration of the inventors attached to the email. See Appendix **D** attached hereto which is a copy of the email sent April 12, 2007. A subsequent email with an electronic copy of the Declaration of the inventors was sent solely to Dr. Aviles on April 25, 2007. See Appendix **E** attached hereto which is a copy of the email sent April 25, 2007.

Co-inventor Dr. Donoff sent an email to Dr. Aviles on May 3, 2007. See Appendix **F** attached hereto which is a copy of the email sent May 3, 2007.

On May 9, 2007, Applicants' representative sent an email to an executive of Dr. Aviles' current employer, requesting further contact information for Dr. Aviles. See Appendix **G** attached hereto which is a copy of the email sent May 9, 2007. The executive responded by giving Dr. Aviles' email address. See Appendix **G**. Another email with the Declaration of the inventors attached was sent to Dr. Aviles on May 9, 2007. See Appendix **H** attached hereto which is a copy of the email sent May 9, 2007 to Dr. Aviles. Dr. Aviles has not responded to any of these four email messages.

Numerous telephone calls have been made by Applicants' representative and by co-inventor Dr. Donoff in attempts to contact Dr. Aviles. Dr. Aviles has returned none of these telephone calls. For these reasons, Applicants' respectfully assert that co-inventor Dr. Walter Aviles is unavailable.

As co-inventor Dr. Aviles is unavailable, Assignee of the entire interest of this application has executed a 37 C.F.R. §1.131 Declaration according to M.P.E.P. §715.04(I). See Appendix **I** attached hereto.

The subject matter of the claims was completed by all of the co-inventors, as evidenced by the Declaration under 37 C.F.R. §1.63 submitted with the application, executed by the four co-inventors. See the 37 C.F.R. §1.131 Declaration of the inventors ¶2; see copies of executed

Declarations under 37 C.F.R. §1.63 attached to the 37 C.F.R. §1.131 Declaration of the inventors, Appendix **A** as Exhibit **A**.

The Declaration of the inventors under 37 C.F.R. §1.131 attached hereto states that Applicants conceived of and reduced to practice the above claims prior to the date of publication of Arnold on July 19, 2000. See Declaration of the inventors, Appendix **A**, ¶2. This Declaration of the inventors shows that a Report of Invention (hereinafter the "Report") was submitted to Harvard University prior to July 19, 2000. A copy of the Report is attached to the Declaration of the inventors as Exhibit **B**.

The Report shows development by the inventors of a realistic virtual reality dental simulator with a haptic interface. See Declaration of the inventors, Appendix **A**, ¶3 and Report p. 1 ¶1. The haptic interface described in the Report provides sensorimotor feedback simulating structural reality of enamel, dentin, and pulp. See Declaration of the inventors, Appendix **A**, ¶3 and Report p. 1 ¶1. Further, a simulated drill described in the Report permits removal of simulated decay and cavity repair. See Declaration of the inventors, Appendix **A**, ¶3, and Report p. 1 ¶1. The prototype simulator in the Report simulates different dental tools virtually. See Declaration of the inventors, Appendix **A**, ¶3, and Report p. 3, section on Dental Instruments.

The prototype simulator shown in the Report involved development of: using haptic enhanced computer graphics to teach and learn dental techniques; dental trainer providing sensorimotor feedback; reusable virtual tooth for simulator; reusable normal and decayed visual and sensory renderings of enamel, dentin, and pulp; instrumentals including virtual amalgam packer and plugger, drill, and explorer; end and side cutting virtual burrs; courseware in form of acceptable basic cavity designs; and intellectual content for amalgam properties to simulate realistic practice. See Declaration of the inventors, Appendix **A**, ¶3, and the Report pp. 2-3 ¶1.

The inventors, in their Declaration, attest to the fact that the prototype was invented prior to July 19, 2000, the publication date of Arnold et al. See Declaration of the inventors, Appendix **A**, ¶5. Since the 37 C.F.R. §1.131 Declaration of the inventors shows conception and reduction to practice prior to the publication date of Arnold et al., Arnold et al. is not proper prior art under 35 U.S.C. §102.

As such, Arnold further is not proper prior art under 35 U.S.C. 103(a). Therefore rejection of claims 1-19, 22-25, and 29-32 under 35 U.S.C. §103(a) in view of this reference can be withdrawn, an action which is respectfully requested.

Summary

On the basis of the foregoing reasons, Applicants respectfully submit that the pending claims are in condition for allowance, which is respectfully requested. If there are any questions regarding these remarks, the Examiners are invited and encouraged to contact Applicants' representatives at the telephone number provided.

Respectfully submitted,

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Appendix **A**